

The Impact of Star Power and Team Quality on NBA Attendance

THESIS

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Abstract

As data analytics has improved rapidly in the past decade, sports analytics is playing a more crucial role in the sports industry. Professional sports leagues like the NBA and MLB have utilized on-field analytics to improve the performance of teams and players. At the same time, team managers use off-field analytics to gain insights on the business side. As a direct indicator of ticket sales, attendance is an important area to study. Many factors affect attendance, but the influence brought by each factor is different. The purpose of this research is to show the impact of star power and team quality on NBA attendance, as well as to determine whether superstar presence or a championship caliber team (or both) drives NBA attendance. The dataset includes attendance data of all NBA teams in the past two seasons (2015-2016 and 2016-2017 seasons). NBA teams are separated into four groups for this research: the high-level team (playoff team) with at least one superstar, the high-level team with no superstars, the low-level team (non-playoff team) with at least one superstar, and the low-level team with no superstars. Each group is tested separately in order to find any differences in attendance. Descriptive analysis results suggest that even a single visiting superstar will increase attendance, and this effect is larger for low-level teams. Moreover, when a team has high attendance variability, the effect of one or more visiting superstars is even larger. Regression models are utilized to find the correlation between star power, team quality, and attendance. Two separate regression models of star power and team quality are tested first in this research, and the results show that both star power and team quality have a significant impact on NBA attendance. However, when the superstar and high-level team are combined together, the high-level team with at least one superstar drives attendance, and the high-

level team without superstars doesn't attract more audience. After analyzing the impact of star power and team quality on NBA attendance, NBA team managers can make specific and targeted marketing strategies to increase ticket sales.

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Introduction

The NBA signed 9-year, \$24 billion TV deals with ESPN and Turner in 2014. This contract was a little bit surprising at first. The NBA league and players knew the value of the new contract would be higher, but they didn't anticipate that the deal would be increased so much. On the other hand, this unexpected deal shows the league's growing popularity. In other words, TV broadcasters are positive about the profit brought by the NBA league in the next decade. The NBA league has put a lot of effort in popularizing their stars. To a certain extent, TV broadcasters have high expectation that those stars have good performance on the court, and TV broadcasters want to attract more audience watching games on TV.

Except for the people before TV, the audience in the stadium is also very important to the NBA. The increasing popularity of the NBA has proven the success of the league's marketing strategy. This research wants to help team managers utilize the growing popularity of the NBA by studying the impact of NBA stars on attracting the audience in the stadium, which could be measured by attendance. On average, ticket sales take about 25% of a basketball team's total revenue. Most of the time, high attendance means high gate revenues. If a stadium has high attendance, it attracts more advertisements and cooperation from other companies. On the other hand, people tend to believe that the quality of the game is another crucial factor attracting fans to buy tickets. In other words, a game involving high-level teams would increase the number of audiences.

In order to show the impact of star power and team quality on attendance prominently, this research pays particular attention to the teams with high attendance variability. This research will also consider other factors affecting attendance including the day of week and game time. In

the end, this study will give management teams some business insights about how to increase attendance and revenues.

Literature Review

Metcalf (2013) wanted to find a relationship between a star player on one team and their impact on attendance when they play in an away game. The result showed that there was a significant difference when LeBron James and Kevin Garnett play in an away game, but there was no significant difference when Chris Paul and Carmelo Anthony play. There were some limitations in Metcalf's study. First, the sample size was small. Metcalf only included 4 superstars in his research, and the data was collected from one season. Second, Metcalf just tested games which occur on the weekend. In order to draw a convincing conclusion, 10 superstars and the data of two consecutive seasons were tested in this research. Weekdays and weekends were important control variables in regression models.

Hausman and Leonard (1997) conducted a research showing that the NBA superstars had a big influence on television ratings, and they also saw the value of superstars to other teams. Hausman and Leonard's research inspired me to examine the impact brought by away team's superstars on attendance since home team's superstars don't vary too much during a season.

Berri, Schmidt, and Brook (2004) examined the relationship between gate revenue and both team performance and star attractions. By their test, Berri, Schmidt, and Brook found that star power was statistically significant, but the consumer demand was more based on the team performance. Berri, Schmidt, Brook's research showed that both star power and team performance of home team affected gate revenue, but this research examined the impact brought by visiting superstars and team quality of visiting teams.

Shih and Chung (2012) conducted their research about fan loyalty. This research suggested that sports team should put more effort in building team identification rather than attracting star players. In other words, based on their research, the team as a whole was more

important to attract fans rather than an individual star player. The study conducted by Shih and Chung was not about the NBA. Stars in a basketball team are more crucial comparing other sports, so this research is different from Shih and Chung's research by paying particular attention to basketball and analyzing how fans perceive basketball.

Berri and Schmidt (2001) used both a time-series analysis and a panel data set to verify that league competitive balance had a significant impact on league attendance, but in another research conducted by Berri and Schmidt (2004), they found a lack of competitive balance in the NBA, which means competitive balance would be a minor factor for attendance in the NBA.

Berri and Schmidt (2006) suggested that superstar externality had an impact on road attendance. Berri and Schmidt found that the finding was consistent with their previous work that team performance plays a more important role in attendance. By their research, Berri and Schmidt said that star power was more important to a team's opponent. Berri and Schmidt previous work focused on the impact of the home team on attendance. In addition, Berri and Schmidt's research was conducted in 2006. As the popularity of the NBA has increased in the past decade, the impact of star power might be different from the influence in 2006.

Berri and Schmidt (2006) claimed that baseball fans no longer treated baseball as a simple pastime. Recently, baseball fans regarded baseball as a business. In this research, authors said that the transition of perception of baseball also happens in other sports league, so fans' perception of NBA would be an important factor for attendance.

Kahane and Shmanske (1997) found that attendance was negatively related to team turnover. Besides star power, team identification, team performance, and competitive balance, team roster turnover is another important factor to consider. In this research, data from two

consecutive seasons were tested in order to diminish the influence brought by team roster turnover.

Primary Hypothesis

The primary hypothesis of this study was that star power and team performance have a significant influence on road attendance. The study focused on road attendance because the number of stars and team quality of the home team didn't vary too much during the season. The impact of star power and team performance brought by the away team is more important to study. This study examined that how attendance varies when the home team plays against the away team with and without superstars. This study also analyzed the difference in attendance when the home team plays against a high-level team and the home team plays against a low-level team.

There were several factors influencing attendance. Some major variables in this study were the number of superstars in the game, the quality of the away team, and the attendance data of each game. First, in order to count the number of superstars, the definition of the superstar should be clarified. People hold different views in terms of the criteria used to define a superstar. Considering the authority and professionalism of sports media, this study chose to use the NBA players ranking list released by ESPN and Sports Illustrated before the beginning of each season. The top 10 players who appear on both lists were considered as the superstars in this study. In the 2016 season, the superstars were LeBron James, Kevin Durant, Anthony Davis, Stephan Curry, James Harden, Chris Paul, Russell Westbrook, Blake Griffin, Marc Gasol, and Kawhi Leonard. In the 2017 season, the superstars were LeBron James, Kevin Durant, Anthony Davis, Stephan Curry, James Harden, Chris Paul, Russell Westbrook, Kawhi Leonard, and Paul George. Besides having the number of stars in the game, the number of stars actually playing in the game was also collected. Superstar players might miss the game due to injury, personal reason, and

team decision. It would be meaningful to see that how attendance changes in response to the absence of superstars.

Another important variable was the team performance. In the NBA, whether a team could make playoffs is an important criterion determining the performance of a team. In this study, the team played in the current season playoffs was viewed as a high-level team. In order to quantify the quality of the team, the study collected pre-game Elo ratings (measurement of team quality) for both teams in the game.

Considering the market size and stadium capacity are different for each team, this research used the proportion to measure attendance. For example, if a stadium capacity is 20,000 seats, and there are 18,000 audiences in this game, the attendance would be $18,000/20,000$, which is 90%.

The attendance data of those teams with high standard deviations was analyzed particularly because there were many teams with high attendance percentage every game in the NBA, so it would be difficult to examine the impact of star power and team quality on the teams with low standard deviations. This research wanted to provide team managers with business insights of the impact on attendance and how to seize the opportunity, so the results of this research would be more valuable for the teams with high standard deviations. Based on the attendance data, Philadelphia 76ers, Milwaukee Bucks, Washington Wizards, Atlanta Hawks, Minnesota Timberwolves and Denver Nuggets were teams with high attendance standard deviations ($>.10$).

Methodology

Data Collection

There was not any existing dataset of NBA attendance, but all attendance data and schedule could be obtained from basketball-reference.com and ESPN. The dataset of this research was created by recording all attendance data of each team and which team they played against in the past two seasons (2016 and 2017). There were 2459 games in the dataset with 28 data points of each game. Besides the attendance data, the dataset included the date and the day of week to determine the influence brought by weekdays and weekends, and game time was also collected in the dataset for the same reason. Each stadium may hold different sports games, so the full capacity of the stadium was determined by the maximum attendance number of that season. After having the attendance percentage of each game, the average attendance and standard deviation were calculated for each team.

Another important part of the dataset was the quality of the team. All teams were divided into two groups. The teams which played current season's playoffs were high-level teams, and the teams which didn't make playoffs were low-level teams. Elo ratings were acquired from FiveThirtyEight. The difference and average of Elo ratings were calculated to determine the quality of the game.

The number of stars was collected separately for the home team and away team. The number of stars who attended the game was also collected separately. The total number of stars was calculated by adding the number of home team stars and away team stars. In addition, there was a note column recording the status of players when they didn't play in that game for further research.

Data Analysis

The descriptive analysis was conducted on the broad level by making tables and graphs in different scenarios. The purpose this step was to see the difference in attendance based on the number of superstars and the quality of the team. First, this research examined the relationship between attendance and the total number of superstars in one game. Second, this research conducted an analysis of attendance difference of playoff teams and non-playoff teams when their opponents add superstars. Next, the attendance difference of teams with high attendance variability was analyzed in this study. The first analysis was about attendance difference of teams with high attendance variability when away team adds a superstar. The second analysis was about attendance difference of teams with high attendance variability against playoff teams and non-playoff teams. The last analysis was the attendance difference of teams with high attendance variability versus the different number of away superstar.

After descriptive analysis, several regression models were built. In order to decrease the impact of other factors on attendance, this research chose to use the day of week and game time as control variables. After running a regression model of day of week and game time, it turned out that only Friday, Saturday, and Sunday have a significant impact on attendance, and game time doesn't have statistically significant difference (Appendix A), so this research defined Friday, Saturday, and Sunday as control variable-weekend and chose to leave game time since it doesn't show any significant difference.

The first regression model was built to test the relationship between attendance percentage and the away superstar. The second regression model was built to examine the relationship between attendance percentage and team quality including away playoff teams and Elo rating of away team. The third regression model was based on four separate groups: the high-level team (playoff team) with at least one superstar, the high-level team with no superstars,

the low-level team (non-playoff team) with at least one superstar, and the low-level team with no superstars. The purpose of this regression model was to analyze the relationship between attendance percentage and different combinations of superstar and team quality. The regression equation was:

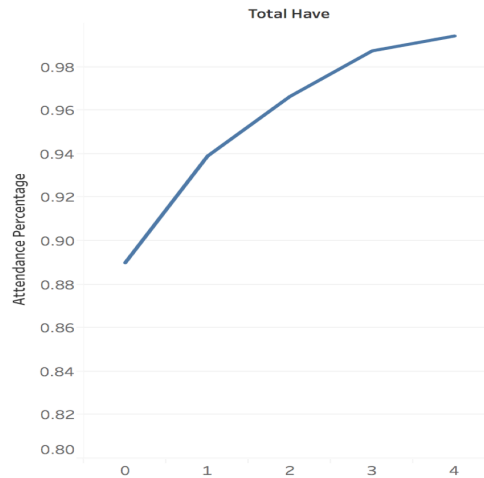
$$\text{Attendance Percentage} = \beta_0 + \beta_1 \text{Weekend} + \beta_2 \text{Away Playoff \& Superstar} + \beta_3 \text{Away Playoff \& No Superstar} + \beta_4 \text{No Playoff \& Superstar} + e$$

In order to show the impact of star power and team quality on attendance prominently, all regression models were tested twice. The first time was tested on all NBA teams, and the second time was only tested on teams with high attendance variability.

Results

Descriptive Analysis

Graph 1: Attendance Difference versus Number of Superstars



The average attendance is 89% when there is no superstar in a game. The average attendance increases to 93% when a game adds one superstar. The average attendance keeps increasing when a game adds more superstars.

Table 1: Attendance Difference of Playoff Teams(1)/Non-Playoff Teams(0) when Away Team Adds Superstar

| Home Playoff | Away Superstar | |
|--------------|----------------|--------|
| 0 | 0 | 0.8726 |
| | 1 | 0.9037 |
| | 2 | 0.9181 |
| 1 | 0 | 0.9422 |
| | 1 | 0.9623 |
| | 2 | 0.9730 |

For the home team which is not a playoff team, the average attendance is 87.26% when the away team has no superstars. The average attendance increases to 90.37% when

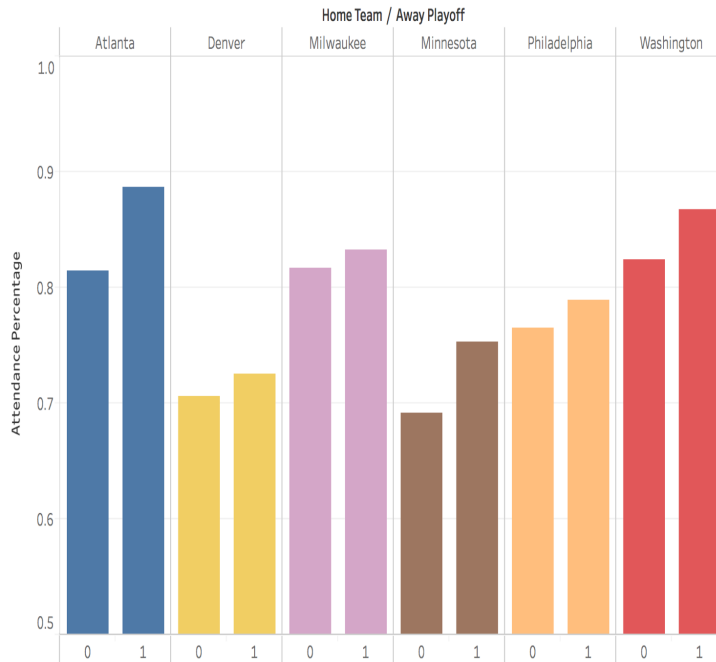
the away team has one superstar, and the average attendance increases to 91.81% when the away team has two superstars. For the home team which is a playoff team, the average attendance is 94.22% when the away team has no superstars. The average attendance increases to 96.23% when the away team has one superstar, and the average attendance increases to 97.30% when the away team has two superstars.

Table 2: Attendance Difference of Teams with High Attendance Variability when Away Team Adds Superstar

| Away Superstar | |
|----------------|---------|
| 0 | 0.77742 |
| 1 | 0.82858 |
| 2 | 0.84520 |

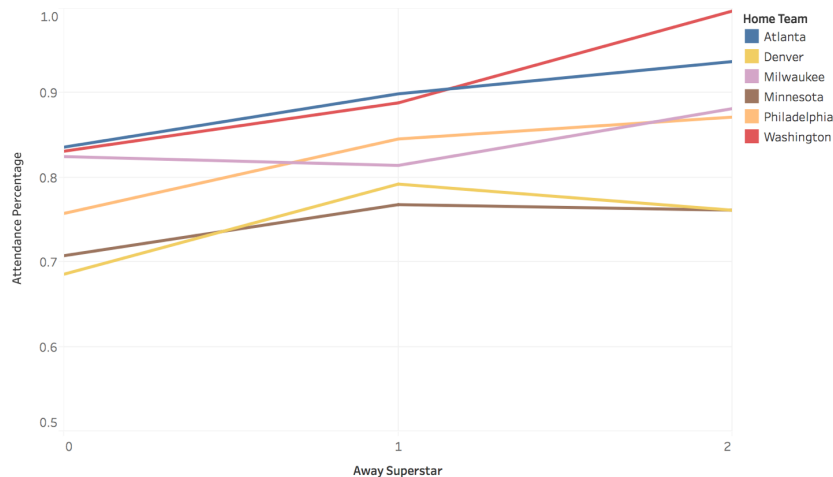
For teams with high attendance variability, the average attendance is 77.74% when the away team has no superstars, and the average attendance increases to 82.86% when the away team has one superstar. The average attendance increases to 84.52% when the away team has two superstars.

**Graph 2: Attendance Difference of Teams with High Attendance Variability against
Playoff Teams(1)/Non-Playoff Teams(0)**



For teams with high attendance variability, the average attendance increases when they play against the playoff team.

**Graph 3: Attendance Difference of Teams with High Attendance Variability versus
Number of Away Superstar**



For the most teams with high attendance variability, the attendance percentage increases when the away team adds more superstars.

Regression Model

Table 3: Relationship between Attendance Percentage and Away Superstar

```

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    0.894543   0.003199 279.650 < 2e-16 ***
`Away Superstar` 0.021863   0.003874   5.644 1.85e-08 ***
Weekend         0.035135   0.004383   8.016 1.68e-15 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1079 on 2453 degrees of freedom
(2 observations deleted due to missingness)
Multiple R-squared:  0.03664,    Adjusted R-squared:  0.03586
F-statistic: 46.65 on 2 and 2453 DF,  p-value: < 2.2e-16

```

The away superstar has a significant impact on attendance. A visiting superstar will increase attendance by 2.19%.

Table 4: Relationship between Attendance Percentage and Away Playoff Team

```

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    0.896068   0.003773 237.497 < 2e-16 ***
`Away Playoff` 0.010683   0.004389   2.434  0.015 *
Weekend         0.034458   0.004404   7.824 7.55e-15 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1085 on 2453 degrees of freedom
(2 observations deleted due to missingness)
Multiple R-squared:  0.02648,    Adjusted R-squared:  0.02569
F-statistic: 33.36 on 2 and 2453 DF,  p-value: 5.054e-15

```

The away playoff team has a significant impact on attendance. A playoff team that comes to town will increase attendance by 1.07%.

Table 5: Relationship between Attendance Percentage and Elo Rating of the Away Team

```
Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    7.670e-01  2.884e-02  26.599 < 2e-16 ***
`Elo Rating of Away Team` 8.954e-05  1.905e-05   4.699 2.76e-06 ***
Weekend        3.459e-02  4.390e-03   7.879 4.90e-15 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1081 on 2453 degrees of freedom
(2 observations deleted due to missingness)
Multiple R-squared:  0.03284,    Adjusted R-squared:  0.03205
F-statistic: 41.64 on 2 and 2453 DF,  p-value: < 2.2e-16
```

Elo rating of the away team has a significant impact on attendance. Attendance percentage will increase 0.89% when Elo rating of the away team increases by 100.

Table 6: Relationship between Attendance Percentage of Teams with High Attendance Variability and Away Superstar

```
Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    0.774985   0.006376 121.545 < 2e-16 ***
`Away Superstar` 0.038872   0.010221   3.803 0.000158 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.134 on 571 degrees of freedom
Multiple R-squared:  0.02471,    Adjusted R-squared:  0.023
F-statistic: 14.46 on 1 and 571 DF,  p-value: 0.0001582
```

Table 7: Relationship between Attendance Percentage of Teams with High Attendance Variability and Away Playoff Team

```

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)   0.767819   0.008366   91.78 < 2e-16 ***
`Away Playoff` 0.034247   0.011301    3.03 0.00255 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1346 on 571 degrees of freedom
Multiple R-squared:  0.01583,    Adjusted R-squared:  0.0141
F-statistic: 9.183 on 1 and 571 DF,  p-value: 0.002554

```

For teams with high attendance variability, the effect is even larger. A visiting superstar will increase attendance by 3.89%. A visiting playoff team will increase attendance by 3.42%.

Table 8: Relationship between Attendance Percentage of Different Groups

```

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)   0.894657   0.003858 231.880 < 2e-16 ***
`Away Playoff & Superstar` 0.028467   0.005599   5.084 3.98e-07 ***
`Away Playoff & No Superstar` -0.001096   0.005174  -0.212   0.832
`Superstar & No Playoff`  0.015846   0.012375   1.280   0.200
Weekend        0.035073   0.004385   7.999 1.92e-15 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.108 on 2451 degrees of freedom
(2 observations deleted due to missingness)
Multiple R-squared:  0.03661,    Adjusted R-squared:  0.03504
F-statistic: 23.28 on 4 and 2451 DF,  p-value: < 2.2e-16

```

In four different groups, the away playoff team with at least one superstar has a significant impact on attendance. The attendance percentage will increase 2.85% when a playoff team with at least one superstar comes to town comparing to a non-playoff team with no superstars. The non-playoff team with one superstar also drives attendance, but

the impact is not significant since there is only one team in the league meeting this criterion.

Discussion

From the results of descriptive analysis and regression models, this research examined the hypothesis that star power and team quality have a significant impact on attendance. After comparing the impact brought by star power and team quality, it's obvious that the star power drives more audience to the stadium. Admittedly, the importance and value of team quality can't be ignored, but NBA fans tend to be attracted more by the away team's superstar. Everyone wants to see LeBron James, Kevin Durant, and Stephen Curry play on the court, but they don't have enough motivation to buy tickets when teams like Portland Blazers and Atlanta Hawks come to town, even though both of them are playoff teams and have stars in their teams.

For those teams with high attendance variability, the results were more apparent. People in cities like Atlanta, Milwaukee, and Minnesota are more likely to buy tickets when a superstar comes to town. None of the teams with high attendance variability has a superstar in their teams. On the other hand, it proves that people would like to watch a superstar play in a game, so they buy tickets to see the away team's superstar. Team managers of the teams with high attendance variability should be aware that there will be a big jump when the away team is a good team or the away team has a superstar. Team managers should make specific and targeted marketing strategies to seize the opportunity. For example, team managers can contact more advertisers because they know there will be more audience in the stadium, so the effect of advertisements will be better. Another example would be to change ticket price based on their opponents. Team managers may increase ticket price when they play against a good team or a team with superstar because fans are willing to pay more to see a good team and a superstar.

For the NBA league and all teams in the league, this research suggested that a superstar attracts more audience than a good team, so they should put more effort in popularizing their stars. There are lots of good players in the NBA, but not all of them are regarded as superstars. If the NBA league and teams can promote more stars and bring them to a higher stage, more people will buy tickets to watch them play. Higher attendance means higher ticket sales and total revenue for the NBA and teams.

Limitations and Further Research

There are some limitations in this research. First, the star power and team quality are highly correlated, so it's hard to distinguish the impact brought by the star power and good team. 9 out of 10 superstars in this research are in a playoff team, so the relationship between attendance and good teams are hard to analyze because there is no good way to control team quality without superstars. This research tried to control team quality and superstars by dividing all teams into 4 different groups. However, another limitation was that there was only one team in the group-the low-level team with at least one superstar, so the sample size was too small to analyze. Second, the list of superstars came from two professional sports media, but many people may disagree with the definition of the superstar in this research, so it would be better if there is an objective definition of the superstar. In addition, this research tried to use Elo ratings to quantify the team quality, but sometimes it didn't work very well.

For further research, this research used the day of week as the control variable. In the future, more control variables could be added in the regression model, so the impact of star power and team quality may be more significant. Moreover, in the 2016 season, Kobe Bryant announced his retirement decision, so people went crazy when Lakers comes to town since many basketball fans wanted to see Kobe's last performance. It was a particular case, and it would be interesting to see the comparison between the impact of a current superstar and the impact of an aging superstar. Another direction of further research could be the test of the impact brought by the number of superstars and the number of superstars who actually played in the game. This research didn't find any

significant difference between the number of superstars and the number of superstars who actually played, but the test could be done more specifically.

Appendix

Appendix A: Relationship between Attendance Percentage and the Day of Week and Game Time

Coefficients:

| | Estimate | Std. Error | t value | Pr(> t) | |
|------------------------|-----------|------------|---------|----------|-----|
| (Intercept) | 0.948352 | 0.011749 | 80.714 | < 2e-16 | *** |
| `Game Time`Night | -0.010189 | 0.010694 | -0.953 | 0.3408 | |
| `Day of Week`Monday | -0.051038 | 0.007688 | -6.638 | 3.89e-11 | *** |
| `Day of Week`Saturday | 0.000799 | 0.007717 | 0.104 | 0.9175 | |
| `Day of Week`Sunday | -0.012815 | 0.008892 | -1.441 | 0.1497 | |
| `Day of Week`Thursday | -0.024593 | 0.009013 | -2.729 | 0.0064 | ** |
| `Day of Week`Tuesday | -0.038832 | 0.008250 | -4.707 | 2.66e-06 | *** |
| `Day of Week`Wednesday | -0.029459 | 0.007114 | -4.141 | 3.58e-05 | *** |

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1084 on 2448 degrees of freedom

(2 observations deleted due to missingness)

Multiple R-squared: 0.02964, Adjusted R-squared: 0.02686

F-statistic: 10.68 on 7 and 2448 DF, p-value: 2.598e-13

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